IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	DiFrancesco et al.
Serial No.	:	10/801,140
For	:	Catalyst Systems
Filed	:	March 12, 2004
Examiner	:	Duong, Tranh P.
Art Unit	:	1797

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AFFIDAVIT OF CHRIS E. DIFRANCESCO PURSUANT TO 37 C.F.R. § 1.132

Dear Sir,

I, Mr. Chris DiFrancesco, do hereby declare the following:

1. I am currently employed by Cormetech Incorporated, the assignee of United States Patent Application Serial No. 10/801,140. I am the Vice President and Chief Technology Officer of Cormetech, Inc. I am additionally a named inventor on the present application.

2. I have been employed by Cormetech since 1991 and have over 17 years experience in the field of selective catalytic reduction (SCR). Prior to 1991, I was employed by Corning, Inc. in the ceramic honeycomb manufacturing field.

3. I have a Bachelor of Science (B.S.) in Chemical Engineering from Carnegie Mellon University.

4. As discussed with the Examiner during the in-person interview at the United States Patent Office on June 17, 2008, United States Patent 4,355,012 to Dettling et al. (hereinafter "Dettling") and United States Patent 5,494,881 to Machida et al. (hereinafter "Machida") each describe a catalyst body comprising a bicomponent structure wherein a catalytically active composition is deposited on and supported by a monolithic non-catalytic substrate. Dettling, for example, recites:

> In accordance with the present invention, there is provided a carrier member adapted to have a catalytic promoting material deposited as a coating thereon and comprising a monolithic body...[1]

Similarly, Machida recites:

> The honeycomb structural catalyst body 10 according to the present invention can be suitably used, e.g., as a catalyst carrier in exhaust gas clarification systems for automobiles....According to the present invention, when the honeycomb structural body 10 is used as a catalyst carrier, for example, the surface of the partition walls 12 is coated initially by a base material, such as γ-alumina or the like, by an amount of no less than 100 g/l with reference to catalyst volume. Subsequently, a catalytic substance consisting essentially of at least one of noble metals among Pt, Rh, and Pd is carried on the surface of the base material...[2]

A construction wherein catalytic material is deposited on a monolithic non-catalytic support is fundamentally different from the presently claimed structural catalyst body. Monolithic non-catalytic supports are made from ceramic materials selected on the ability to provide suitable mechanical properties without consideration to catalytic properties or catalytic performance. Similarly, inorganic and organic binders can be selected for use in non-catalytic supports with minimal regard to catalytic activity or performance. Sodium based organic binders, for example, may be chosen for non-catalytic supports for their advantageous rheological properties. Sodium based binders, however, poison catalytic materials used in selective catalytic reduction and are, therefore, precluded from use with such materials.

Moreover, non-catalytic supports are processed under conditions which provide enhanced mechanical properties without consideration to affects on catalytic properties or catalytic performance. Non-catalytic supports, such as those described in Dettling and Machida, for example, may be sintered at high temperatures to increase the strength of the non-catalytic support. Sintering at high temperatures is not available for catalytic materials since it will reduce or destroy surface area available for catalytic reaction.

Furthermore, as a result of the supported construction, the structural catalyst bodies described by Dettling and Machida do not have catalytic material dispersed throughout the outer peripheral wall and inner partition walls as presently claimed. The catalytic material resides only on the surface of the non-catalytic support.

5. In view of the foregoing fundamental structural differences, Dettling and Machida do not teach or suggest a structural catalyst body as presently claimed. The enhanced mechanical properties provided by the monolithic non-catalytic supports of Dettling and Machida resulting from processing conditions not available to catalytic materials preclude direct comparison with catalyst bodies of the present invention. As discussed herein, catalyst bodies of the present

[1] Dettling, Column 3, lines 34-50.
[2] Machida, Column 6, lines 47-65.

invention are formed from compositions comprising catalytic material and thereby exclude monolithic non-catalytic supports.

Moreover, combining Dettling and Machida with EP 0 631 805 (hereinafter EP '805) is meaningless to one of skill in the art since Dettling and Machida teach catalyst bodies comprising monolithic non-catalytic supports and EP '805 teaches catalyst bodies excluding monolithic non-catalytic supports. The catalyst bodies of EP '805 are produced by the extrusion of a catalytic composition. In view of the fabrication advantages afforded monolithic non-catalytic supports not available to the catalyst bodies of EP '805, there is no teaching or reason to believe that a hydraulic diameter and macroporosity provided by a monolithic non-catalytic support of Dettling and Machida can be incorporated into an non-supported extruded catalyst body. The calculations and parameters discussed below provide additional evidence that one of skill in the art would not think it possible to produce an extruded catalyst body comprising an inner partition wall thickness of less than 0.22 mm and having a hydraulic diameter and macroporosity consistent with that recited in Dettling and Machida.

Furthermore, modification of the catalyst bodies of Dettling and Machida to arrive at a structural catalyst body of the present invention would require abandonment of the monolithic non-catalytic support. As Dettling and Machida only contemplate supported catalytic structures, these references fail to provide any teaching or suggestion of how to provide a structural catalytic body not comprising a monolithic non-catalytic support, much less a structural catalytic body not comprising a monolithic non-catalytic support having sufficient mechanical properties to withstand the demanding conditions of a catalytic reactor.

6. Also discussed with the Examiner was the prior art example provided in the specification of the present application. Similar to EP '805, the structural catalyst body of Example 1 does not comprise a monolithic non-catalytic support.

7. Prior art Example 1, however, differs significantly from the presently claimed structural catalyst bodies. Example 1 provides a structural catalyst body having an inner partition wall thickness of 0.27 mm, a hydraulic diameter of 150 mm and a macroporosity of 0.04 cc/g in pores of diameter ranging from about 600 to 5,000 Angstroms. Example 1 does not provide a structural catalyst body comprising a wall thickness of less than 0.22 mm, a hydraulic diameter of greater than or equal to 150 mm and a macroporosity greater than or equal to 0.05 cc/g in pores of diameter ranging from 600 to 5,000 Angstroms.

Moreover, it is not obvious to produce a structural catalyst body of the present invention having an inner wall thickness less than 0.22 mm, a hydraulic diameter greater than or equal to 150 mm and a macroporosity greater than or equal to 0.05 cc/g in pores of diameter ranging from 600 to 5,000 Angstroms based on the disclosure of prior art Example 1.

Attached hereto are a series of parameters and calculations characterizing structural aspects of the catalyst body of prior art Example 1 and structural aspects of catalyst bodies of the present invention as set forth in Examples 2 and 3 of the present application. As provided in the attachment, the catalyst body of Example 2 displays inner partition walls that are over 22% thinner than the inner partition walls of the catalyst body of Example 1 (0.21 mm v. 0.27 mm).

Moreover, the catalyst body of Example 3 demonstrates inner partition walls about 26% thinner than the inner partition walls of the catalyst body of Example 1 (0.20 v. 0.27).

Additionally, the catalyst body of Example 2 has a macroporosity greater than or equal to 0.09 cc/g in pores of diameter ranging from 600 to 5,000 Angstroms, which is a 125% increase over the macroporosity of the catalyst body of Example 1. The catalyst body of Example 3 has a macroporosity of 0.06 cc/g in pores of diameter ranging from 600 to 5,000 Angstroms, which is a 50% increase over macroporosity of the catalyst body of Example 1.

Macroporosity is an important parameter since macropores facilitate diffusion of reactants into the catalyst wall thereby improving catalytic performance. However, a high concentration of macropores or high macroporosity weakens the mechanical integrity of the catalyst body as less structural surface area is present.

As a result of the significant decrease in inner partition wall thickness compared to Example 1, the pressure experienced on the bottom walls of a green (unfired) catalyst body of Example 2 increases from 554 kg/m^2 to 595 kg/m^2. Moreover, the pressure on the walls of a fired catalyst body of Example 2 at a compressive loading of 1.5 kg/cm^2 increases from 118,230 kg/m^2 to 153,133 kg/m^2 in comparison to Example 1, a 29.5% increase. Furthermore, as a result of wall thinning,, the critical pressure to structural failure of the catalyst body of Example 2 decreases relative to that of Example 1. This is illustrated in the ratio of critical pressure for structural failure to minimum elastic modulus. The ratio of critical pressure for structural failure to minimum elastic modulus for the catalyst body of Example 2 is 0.47, a 43.3% decline from the same ratio for Example 1.

Significantly increasing the pressure experienced by the bottom walls of a green catalyst body while significantly decreasing the critical pressure to structural failure substantially increases the likelihood that the catalyst body will collapse under its own weight. This is especially true during handling and transport of the green catalyst body prior to firing. Moreover, significantly increasing the pressure experienced by substantially thinner inner partition walls of a fired catalyst body also increases the likelihood the catalyst body will fail when subjected to the harsh operational conditions of a catalytic reactor.

Furthermore, the catalyst body of Example 2 exhibiting a hydraulic diameter of 151 mm provides additional distinction over prior art Example 1. As defined in the specification, hydraulic diameter is equal to the cross-sectional area perpendicular to the direction of flow of the catalyst body multiplied by four and divided by the value of the outer perimeter of the outer peripheral wall. From this definition, the hydraulic diameter characterizes the size of the catalyst body with larger hydraulic diameters equating to larger catalyst bodies.

A hydraulic diameter of 151 mm is relatively large indicating a greater mass to support for the catalytic body of Example 2. As a result, a hydraulic diameter of 151 mm is inconsistent with the critical pressure to failure calculated for the catalyst body of Example 2. Based on the critical pressure to failure, the catalyst body of Example 2 should display a hydraulic diameter of 79 mm to prevent collapse of the catalyst body. The fact that the catalyst body of Example 2 displays a hydraulic diameter of 151 mm without collapse is a further indicia of non-

obviousness. Moreover, based on the foregoing, even a hydraulic diameter of 100 mm coupled with an inner partition wall thickness less than 0.22 mm and a macroporosity greater than 0.05 cc/g is unexpected and, therefore, not contemplated by Example 1.

The results are similar for the catalyst body of Example 3. As a result of the significant decrease in inner partition wall thickness compared to Example 1, the pressure experienced on the bottom walls of a green (unfired) catalyst body of Example 3 increases from 554 kg/m^2 to 597 kg/m^2. Moreover, the pressure on the walls of a fired catalyst body of Example 3 at a compressive loading of 1.5 kg/cm^2 increases from 118,230 kg/m^2 to 160,779 kg/m^2 in comparison to Example 1, a 36.0% increase. Furthermore, as a result of wall thinning, the critical pressure to structural failure of the catalyst body of Example 3 decreases relative to that of Example 1. The ratio of critical pressure for structural failure to minimum elastic modulus for the catalyst body of Example 3 is 0.42, a 49.4% decline from the same ratio for Example 1.

Additionally, based on the critical pressure to failure, the catalyst body of Example 3 should display a hydraulic diameter of 70 mm to prevent collapse of the catalyst body. The catalyst body of Example 3, however, demonstrates a hydraulic diameter of 151 mm. Based on the foregoing, even a hydraulic diameter of 100 mm coupled with an inner partition wall thickness less than 0.22 mm and a macroporosity greater than 0.05 cc/g is unexpected and, therefore, not contemplated by Example 1.

The foregoing discussion provides no reasonable expectation to one of skill in the art that catalyst bodies of the present invention can be produced and function in a catalytic reactor. As a result, Dettling, Machida, EP '805 and the prior art examples provided in the specification of the present application do not render the structural catalyst bodies of the present invention unpatentable.

8. I further declare that all statements made herein are of my own knowledge, are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the present application or any patent issuing thereon.

8/22/08
Date

Mr. Chris E. DiFrancesco

STATE OF NORTH CAROLINA

COUNTY OF DURHAM

Before me, a Notary Public in and for the State of North Carolina on this 22nd day of August, 2008, personally appeared Chris E. DiFrancesco, who being duly sworn, signed and acknowledged the foregoing Assignment as his/her free act and deed.

SUSAN G DENAULT NOTARY PUBLIC DURHAM COUNTY, N.C. (Seal)

NOTARY PUBLIC SUSAN G DENAULT
My Commission Expires 7/16/2013

Description	Example 1 from application	Example 2 from application	Example 3 from application
Inputs			
Dh - Hydraulic Diameter - mm	150	151	151
n - Cells - #	70	70	70
o - Outer Wall - mm	0.65	0.57	0.57
w - Inner Wall Thickness - mm	**0.27**	**0.21**	**0.2**
d - Density of material Kg/m3	2000	2100	2100
Intermediate Outputs			
c - Cell Size - mm [(Dh-2*o-(n-1)*w)/n]	1.86	1.93	1.94
p - Pitch - mm [c+w]	2.13	2.14	2.14
OFA - Open Frontal Area - - [(c^2*n^2)/Dh^2]	0.75	0.80	0.81
Outputs			
Pw - Pressure on bottom walls of extrudate due to its own weight (approx) - Kg/m2 [d*(n*(w+c)/1000+(n-1)*c/1000)]	554	595	597
Pc/Em - Critical Pressure / Minimum Elastic Modulus, based on Euler's Theory - [4*pi^2/(c/w)^2]	0.83	0.47	0.42
Pwf - Pressure onwalls of fired product due to 1.5 Kg/cm2 of packing pressure - Kg/m2 [ ]	118230	153133	160779
Comparison of Cases			
Rpw - Relative increase in pressure on bottom walls [Pw / Pw for case A]		1.074	1.076
Rpc - Relative critical pressure for bottom wall to collapse at minimum elastic modulus for case A [(Pc/Em) / (Pc/Em) for case A] (< 1 means that the wall is likely to collapse)		0.558	0.501
Expected required increase in Minimum Elastic Modulus to prevent collapse of bottom wall. [Rpw/Rpc]		**1.92**	**2.15**
Or expected required Hydraulic Diameter to reduce load on bottom walls and prevent requirement to increase Minimum Elastic Modulus (approximate) mm - [Dh / (Rpw/Rpc)]		**79**	**70**
Rpwf - Relative increase in pressure on walls of fired product due to packing pressures [Pwf / Pwf for case A]		**1.295**	**1.360**